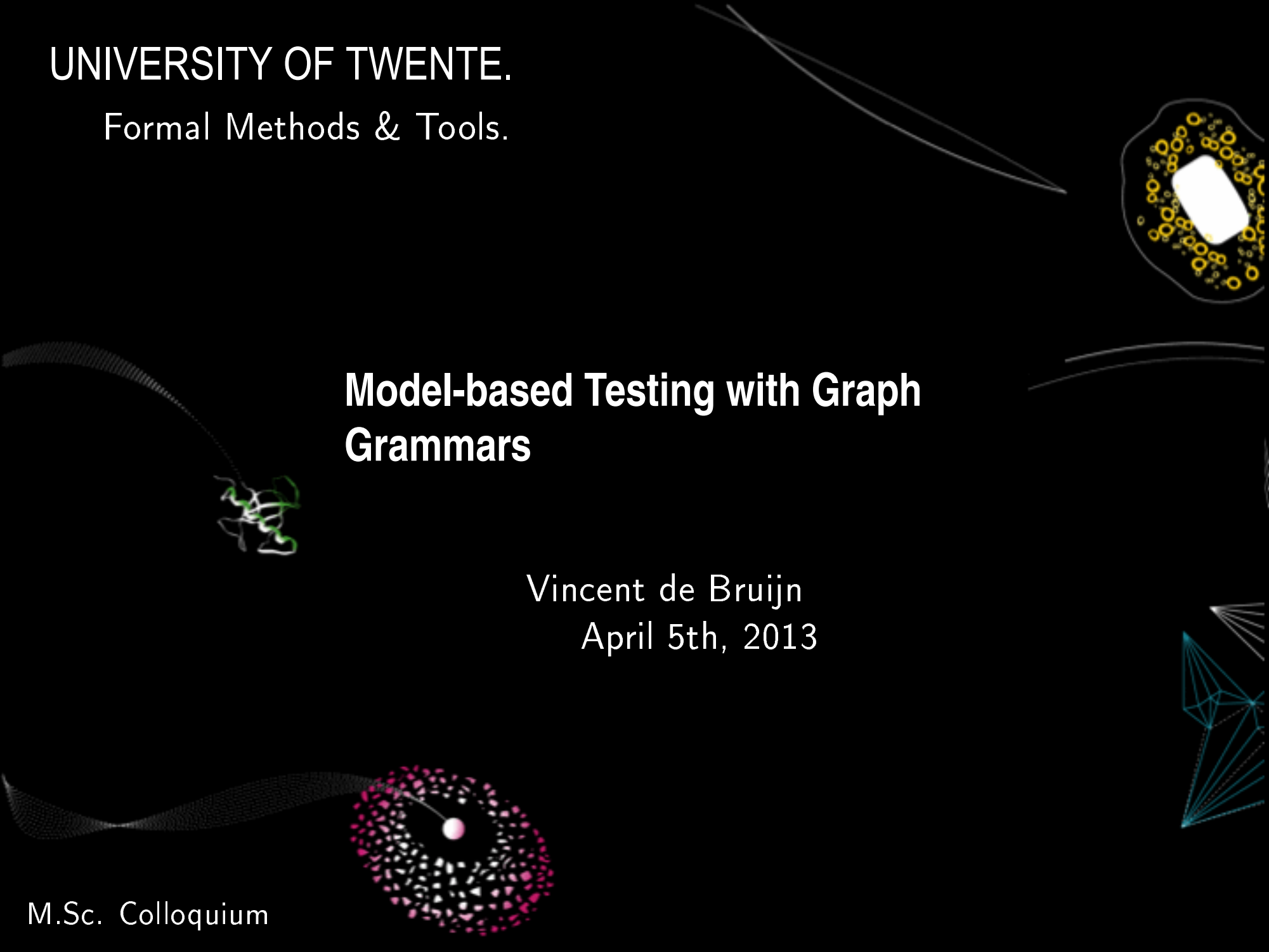
UNIVERSITY OF TWENTE.

Formal Methods & Tools.



Model-based Testing with Graph Grammars

Vincent de Bruijn

April 5th, 2013

M.Sc. Colloquium

Contents

Testing (1/3)

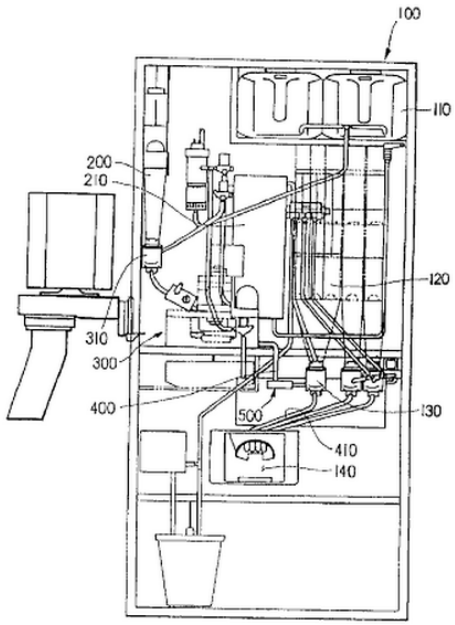
- Why do we test?
  - Products have requirements
  - Software implementation should uphold requirements

Testing (2/3)

- Creating tests manually:
  - Error-prone
  - Time intensive

Testing (3/3)

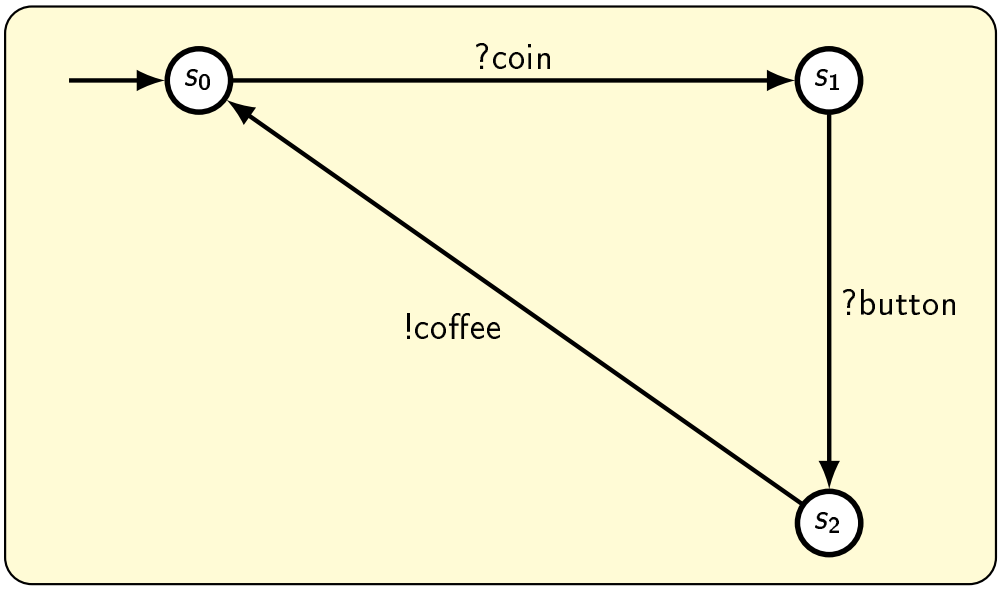
- Solution
  - Create ‘model‘ from the requirements
  - Generate tests automatically using model



Models (1/2)

Model

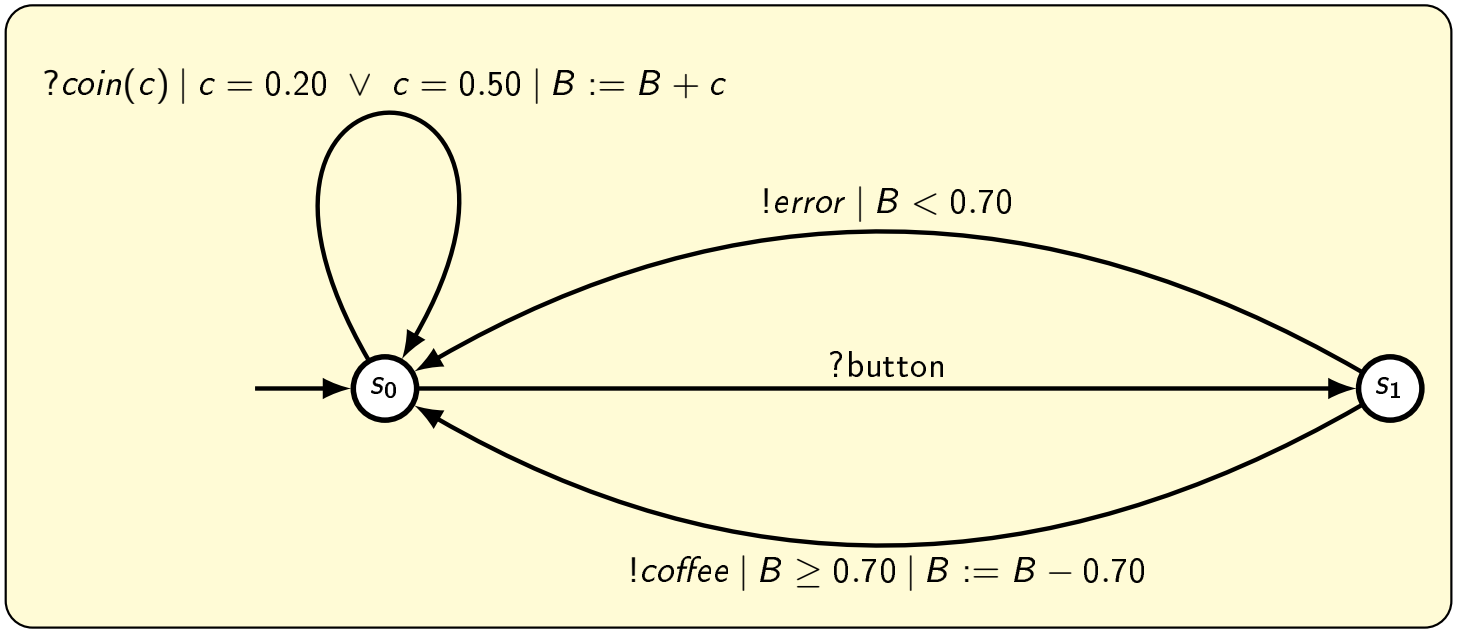
- An abstract representation of the behavior of a system



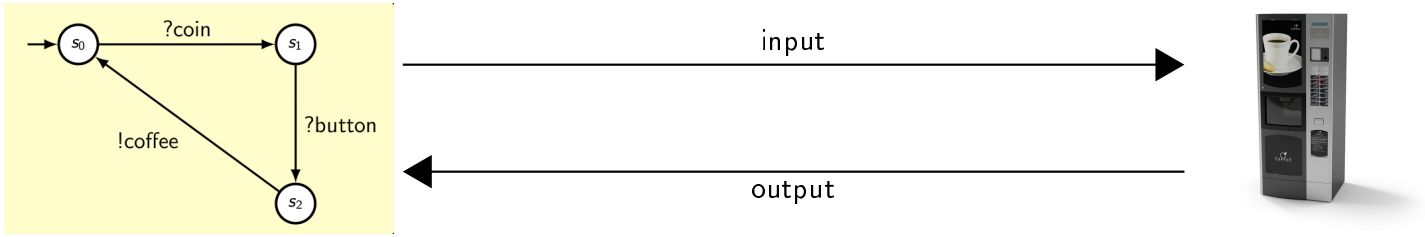
Models (2/2)

Symbolic Transition System (STS)

- Transition system with *variables*, *constraints* and *updates*

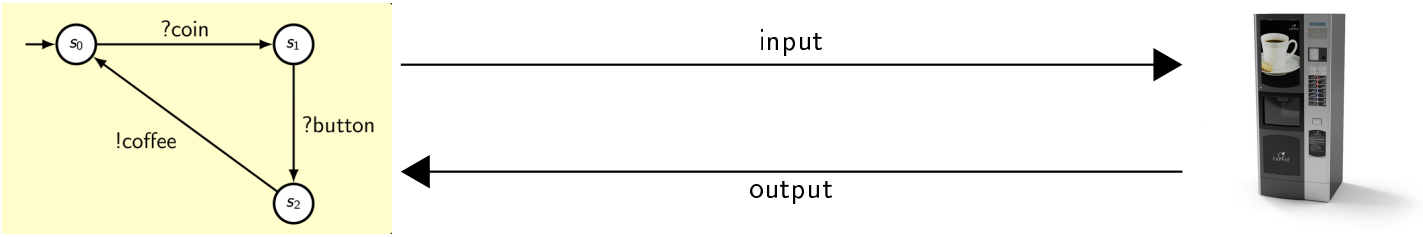


Model-based Testing (1/1)



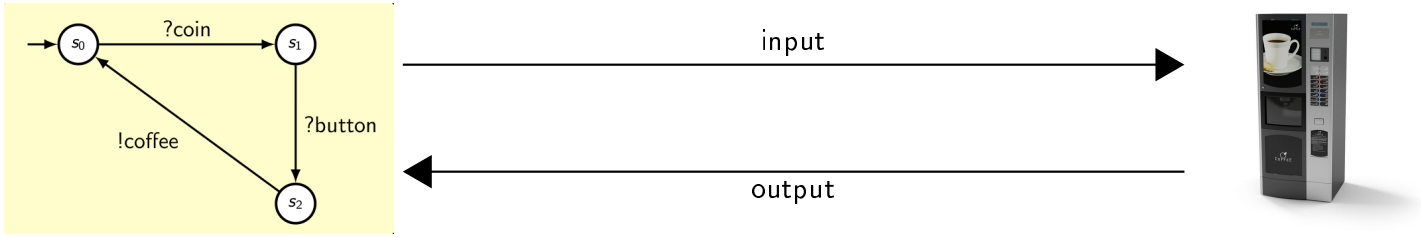
1. Take possible input from model

Model-based Testing (1/1)



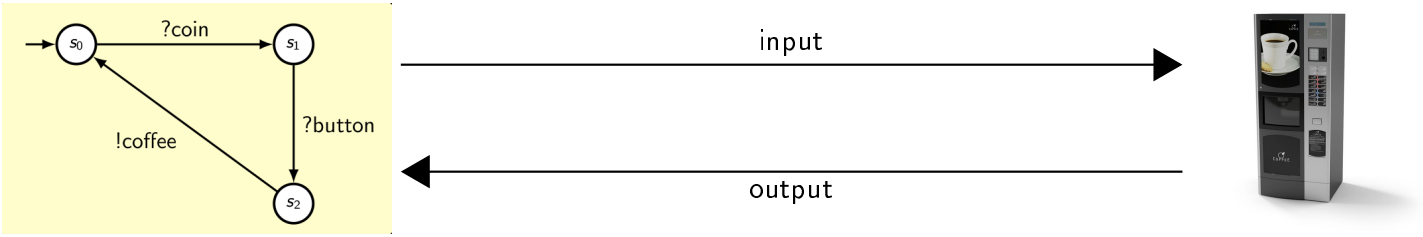
1. Take possible input from model
2. Apply input to the System Under Test (SUT)

Model-based Testing (1/1)



1. Take possible input from model
2. Apply input to the System Under Test (SUT)
3. Observe output

Model-based Testing (1/1)



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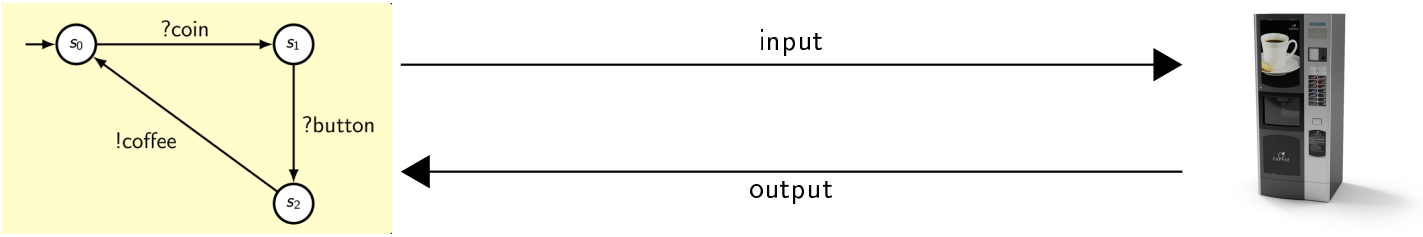
4. Check if output is according to model

Model-based Testing (1/1)

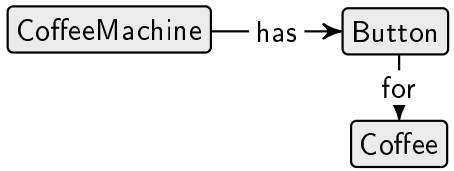


1. Take possible input from model
2. Apply input to the System Under Test (SUT)
3. Observe output
4. Check if output is according to model
5. Notify tester whether test passed or failed

Graph Grammars (1/6)

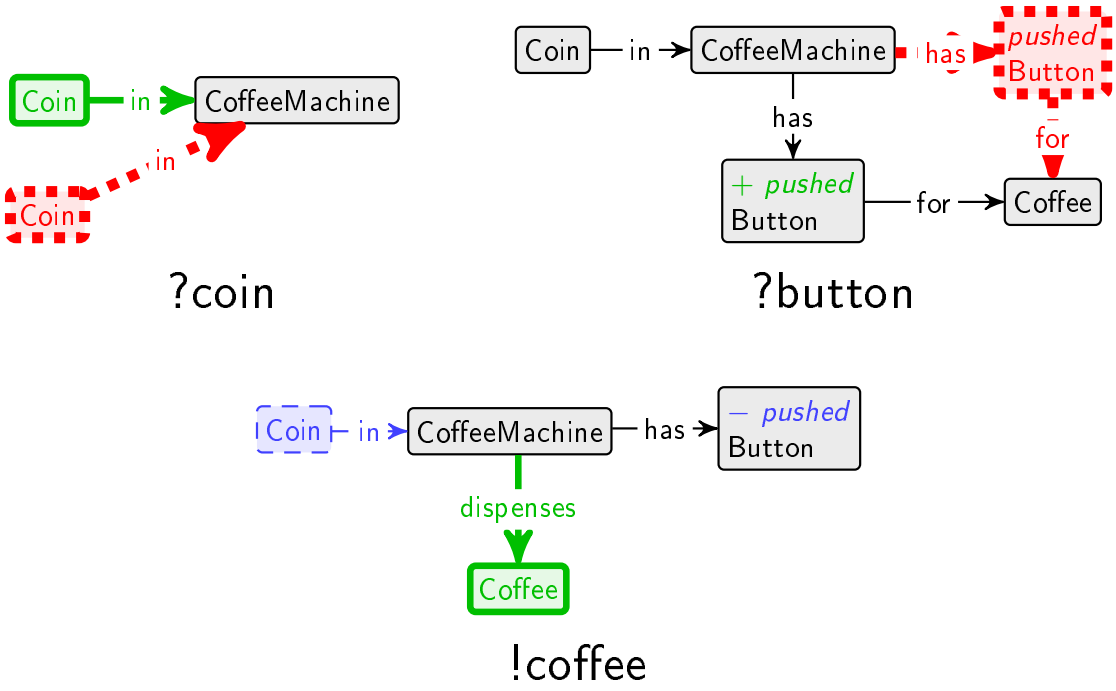
- Graphs represent system states
- Graph rules represent behavior of the system

coffee machine



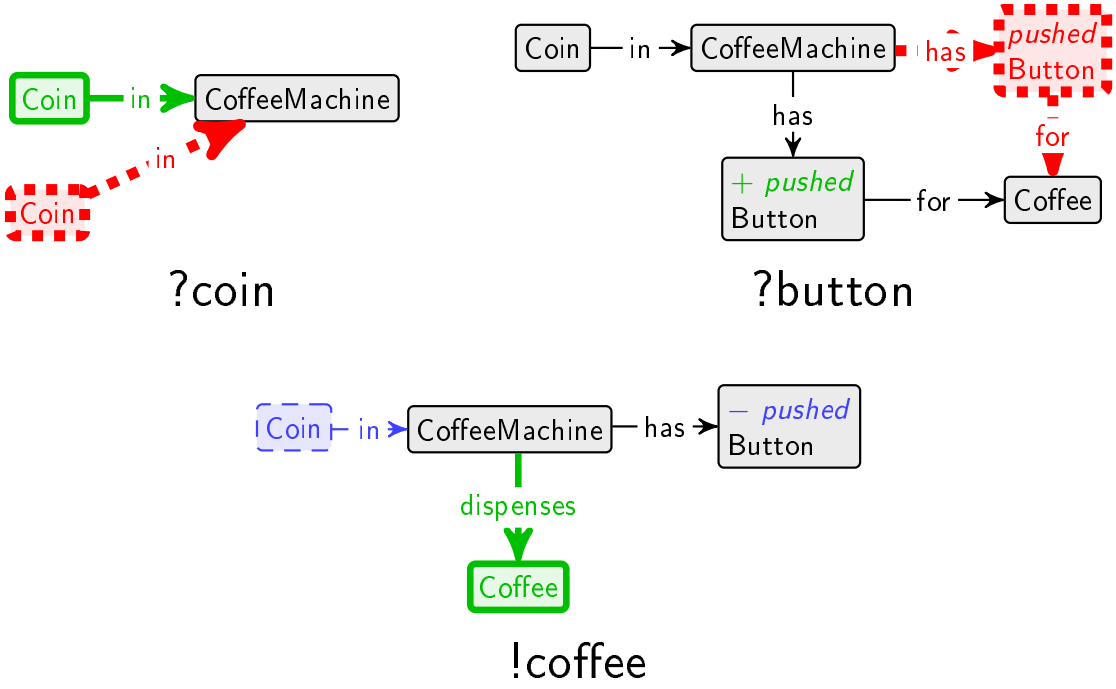
graph

Graph Grammars (2/6)



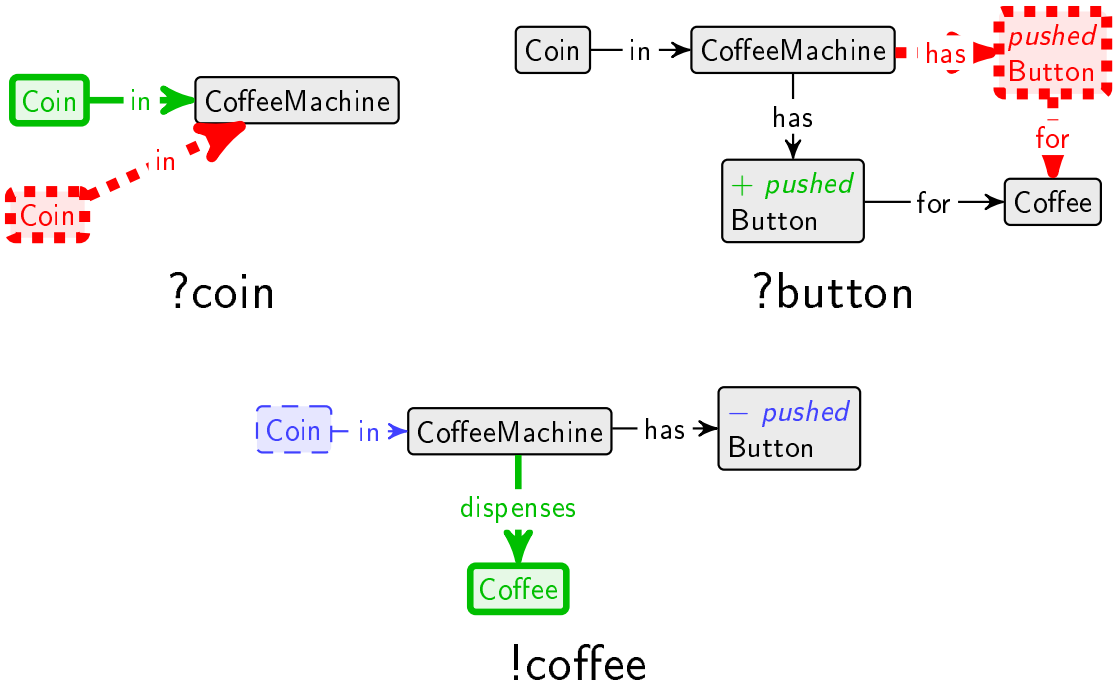
- Black and blue parts have to be present in graph

Graph Grammars (2/6)



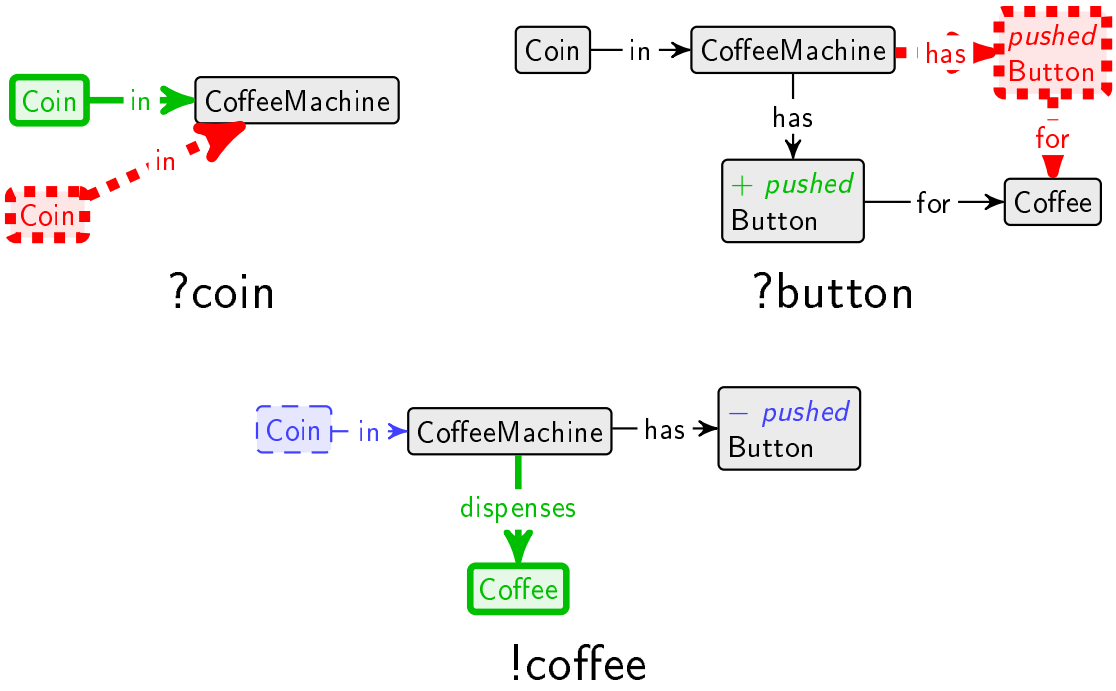
- Black and blue parts have to be present in graph
- Red parts may not be present in graph

Graph Grammars (2/6)



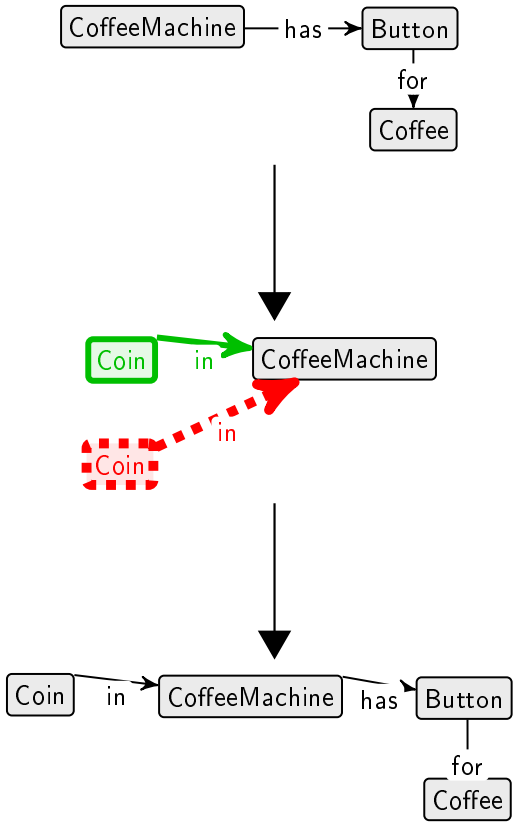
- Black and blue parts have to be present in graph
- Red parts may not be present in graph
- Blue is erased from graph

Graph Grammars (2/6)

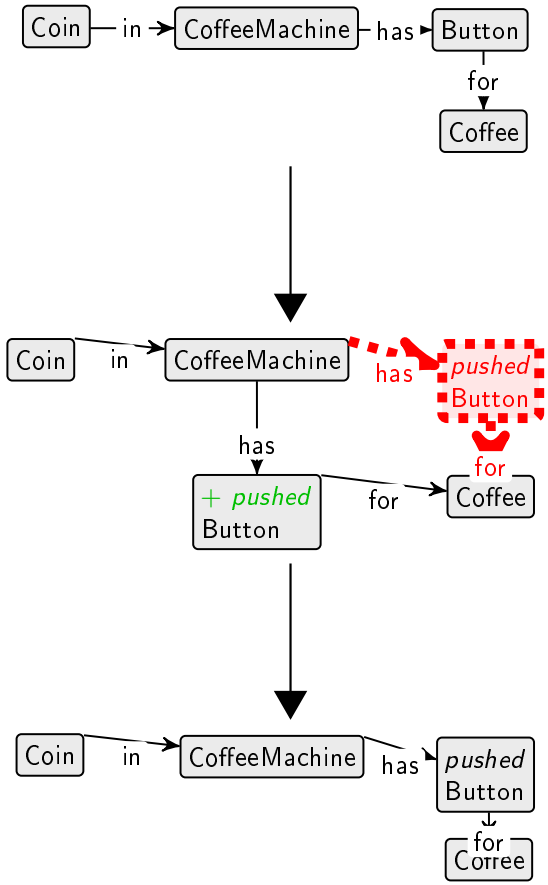


- Black and blue parts have to be present in graph
- Red parts may not be present in graph
- Blue is erased from graph
- Green is added to graph

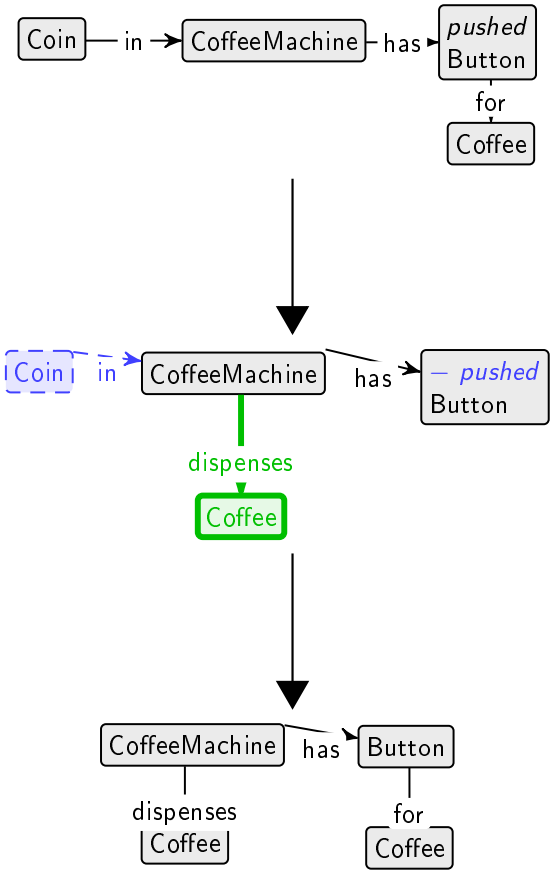
Graph Grammars (3/6)



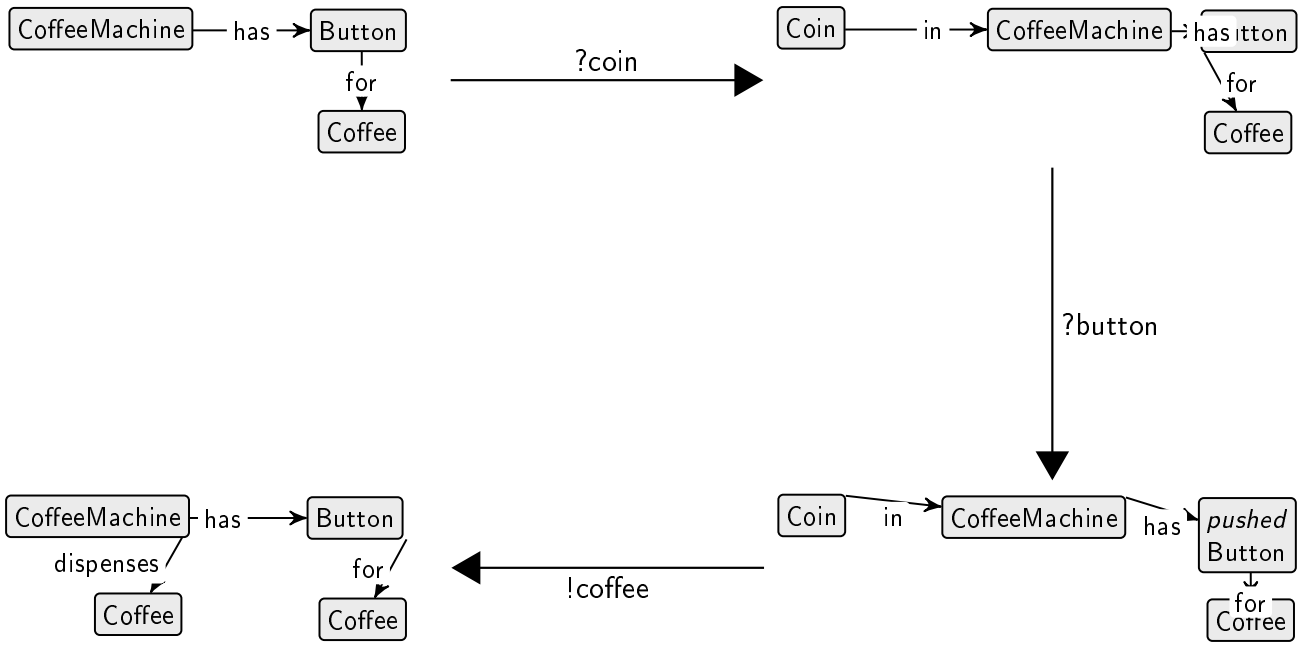
Graph Grammars (4/6)



Graph Grammars (5/6)

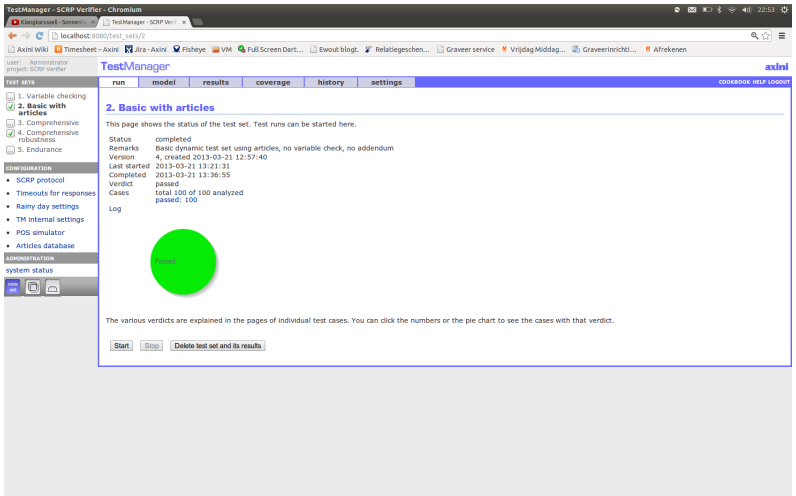


Graph Grammars (6/6)

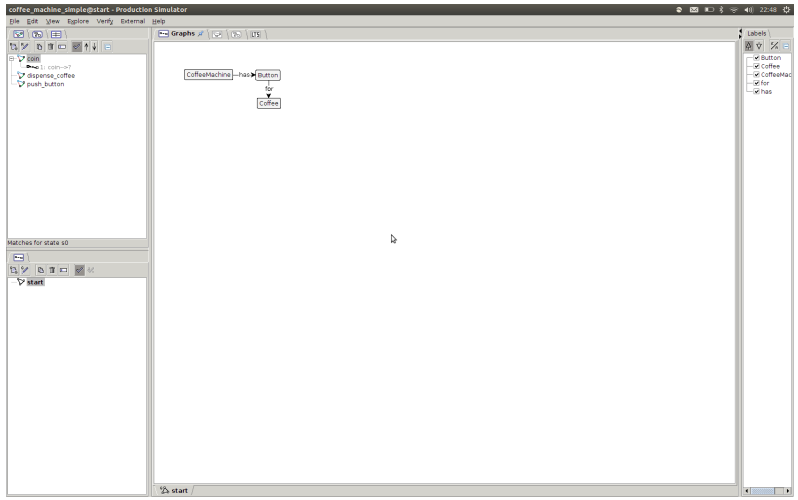


Tools or how I got to do this research

- Axini Test Manager (ATM) (uses STSs)
- GRaphs for Object-Oriented VErification (GROOVE) (uses Graph Grammars)



ATM



GROOVE

Research Goals

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  - Use GROOVE and ATM to create model-based testing tool with Graph Grammars

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- Goals
  - Use GROOVE and ATM to create model-based testing tool with Graph Grammars
  - Validate this tool using case studies
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  - Graphs are well-known and often used to represent system states
  - Rules are useful for describing computations

Contents

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Setup

- Make a tool GRATiS (GRoove-Axini Testing System)

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  2. Generate STS from Graph Grammar
  3. Model-based test system with STS

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Case study: Coffee machine (1/9)

Requirements:

- Dispense coffee and tea

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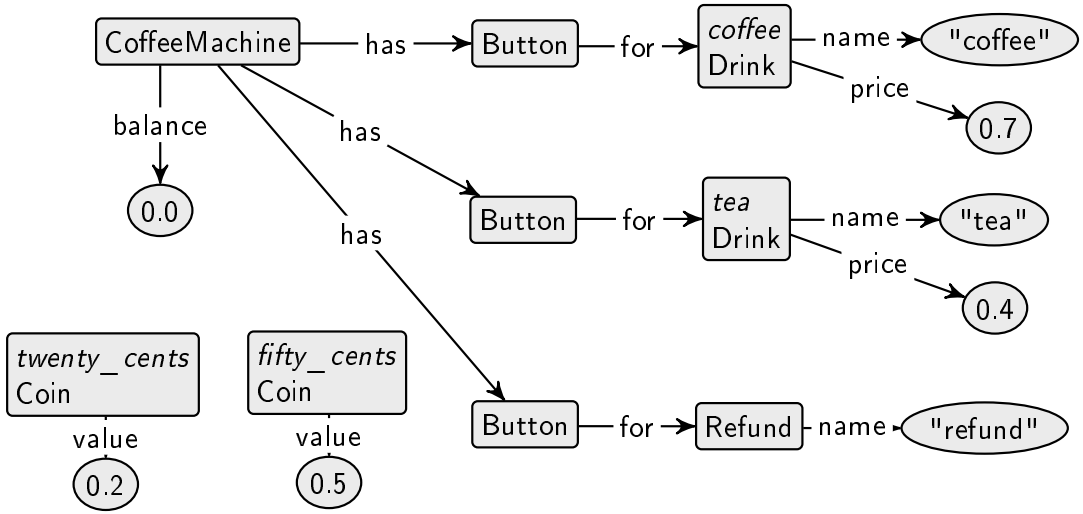
- 0.20 and 0.50 cent coins can be entered
- Entered coins can be refunded

Case study: Coffee machine (1/9)

Requirements:

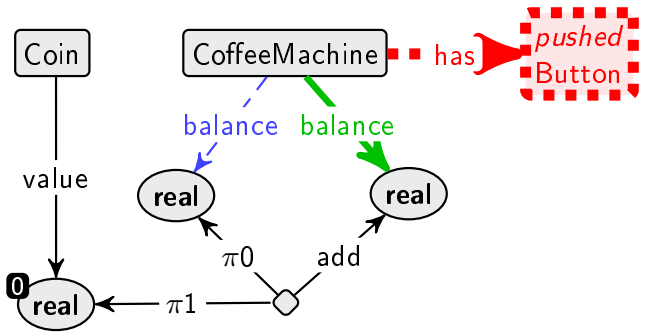
- Dispense coffee and tea
- Coffee costs 0.70 cts, tea costs 0.40 cts
- 0.20 and 0.50 cent coins can be entered
- Entered coins can be refunded
- Machine gives error when drink requested but not enough coins entered.

Case study: Coffee machine (2/9)



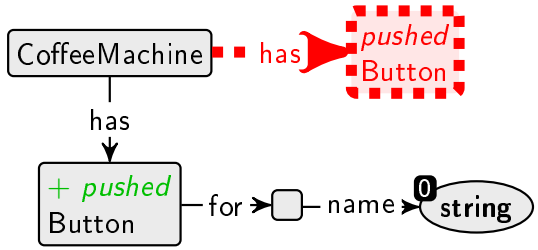
Coffee Machine start graph

Case study: Coffee machine (3/9)



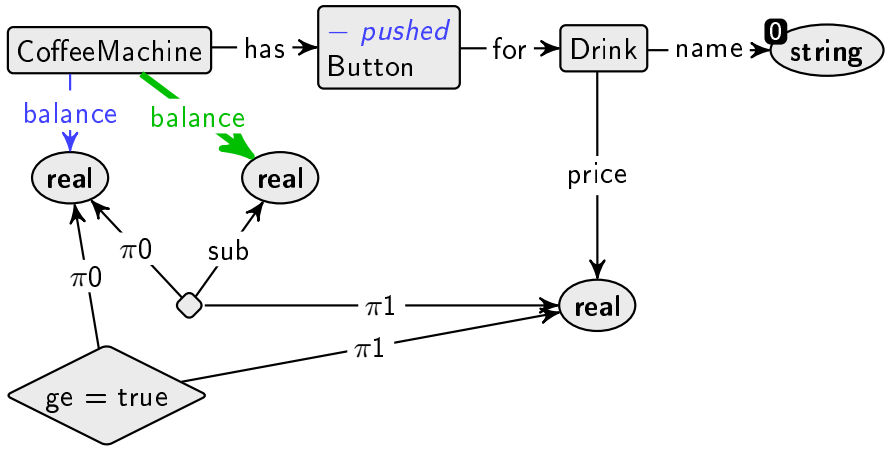
?coin(c)

Case study: Coffee machine (4/9)



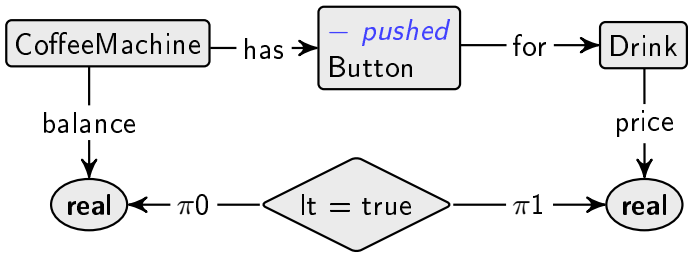
?button(b)

Case study: Coffee machine (5/9)



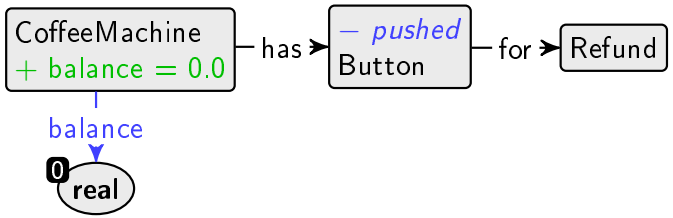
!drink(d)

Case study: Coffee machine (6/9)



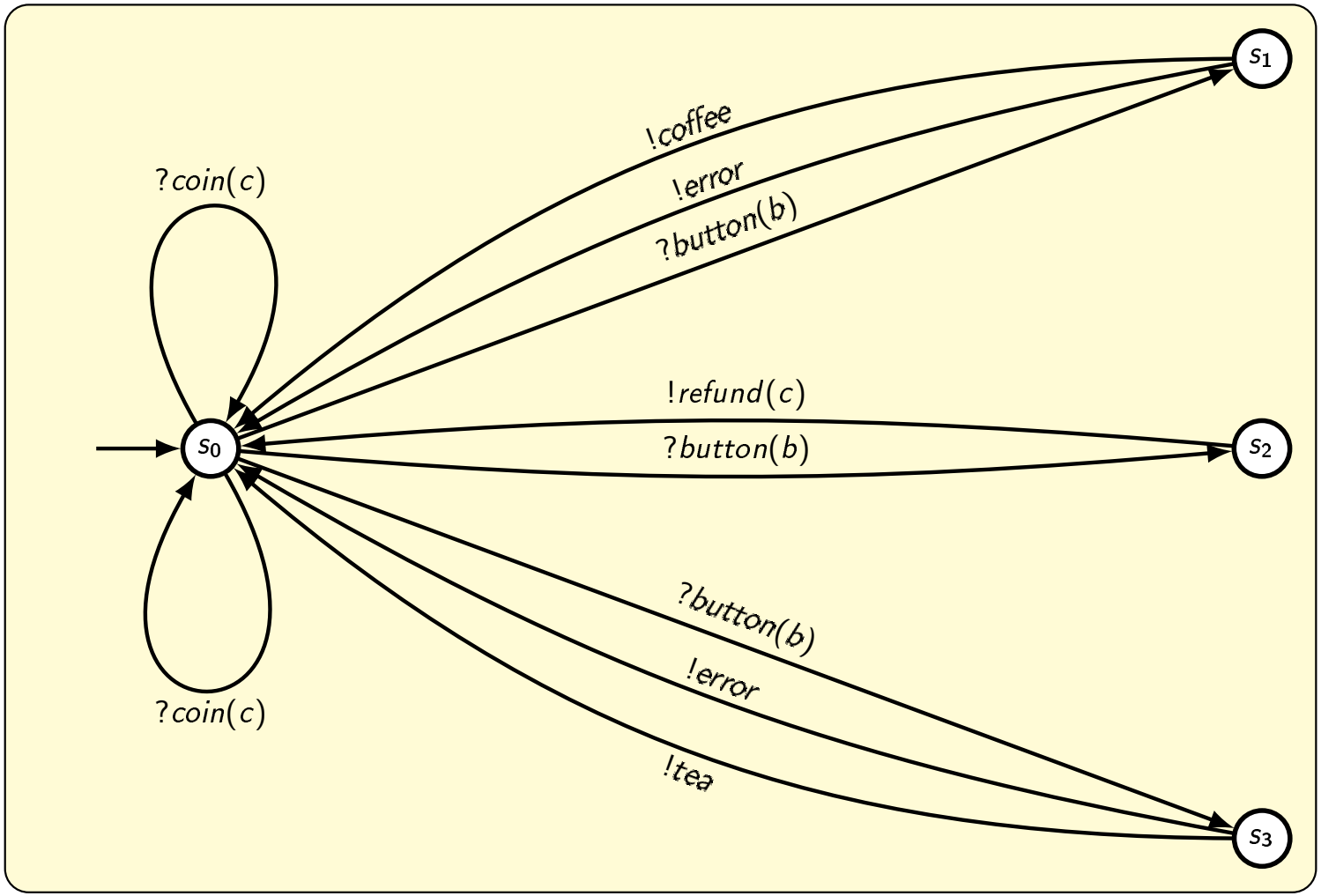
!error

Case study: Coffee machine (7/9)

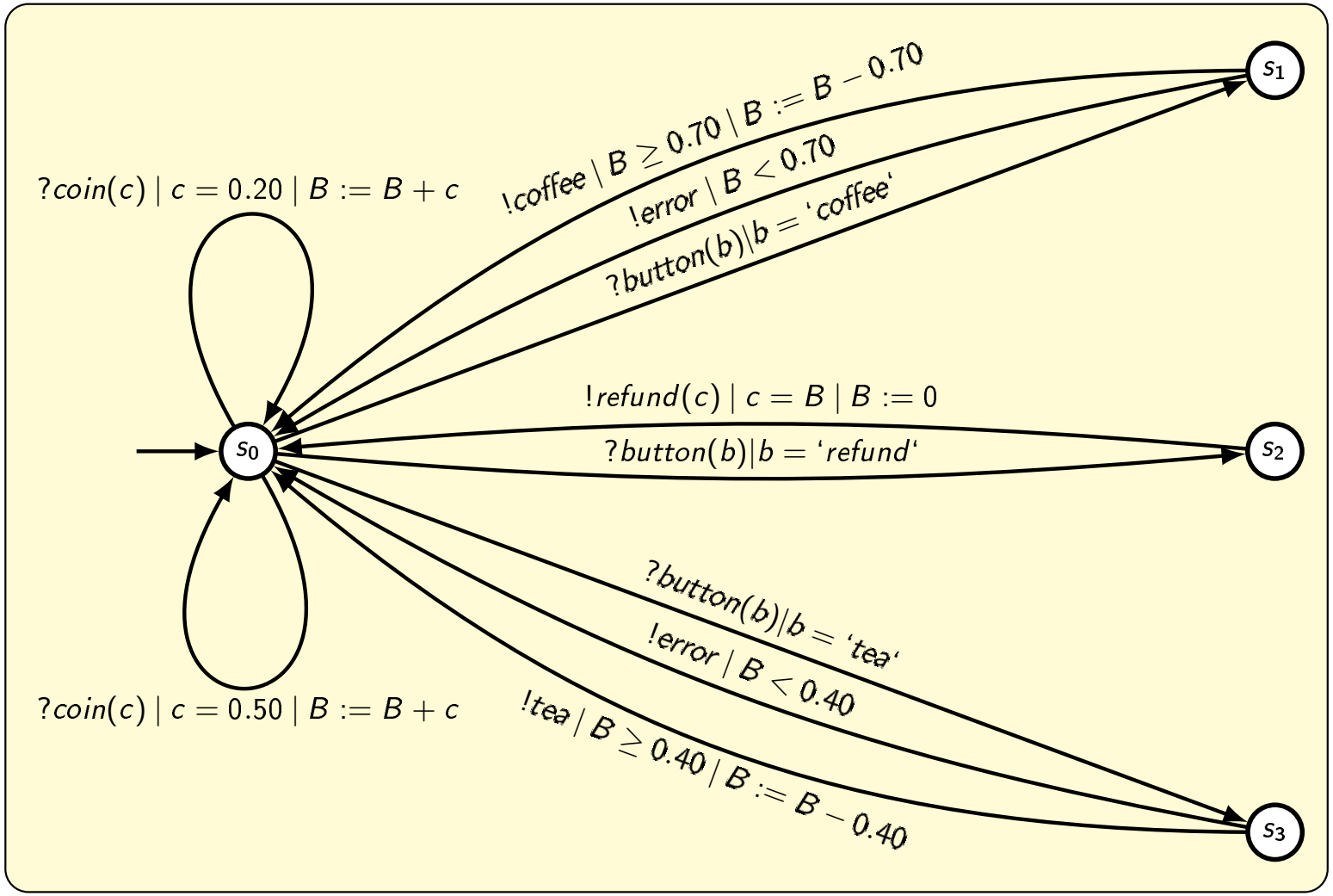


!refund(b)

Case study: Coffee machine (8/9)

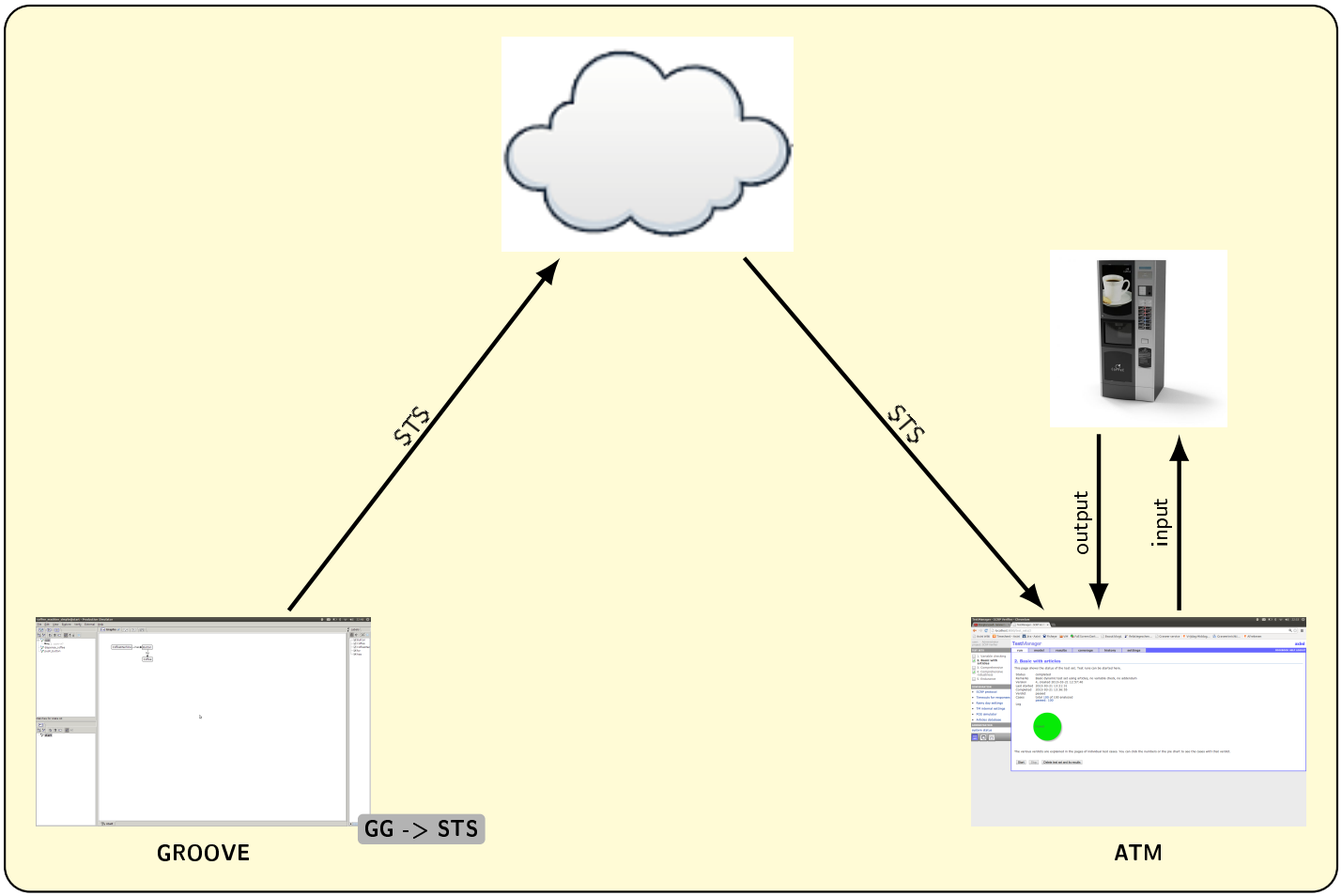


Case study: Coffee machine (9/9)



Contents

Implementation



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Model Examples

- 5 example cases used:

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  1. a boardgame

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- Compare models

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- Model complexity (Is there a difference in complexity between the STS and the Graph Grammar?)
- Extendability (How easy is it to adapt both models to a hypothetical extension?)

Measurement conclusions

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- Redundancy: Technique can create redundant STSs
- Model complexity: Both are equally complex
- Extendability: Varying results

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Conclusion

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Conclusion

- Created method of generating STSs from Graph Grammars
- Implemented a tool for model-based testing with Graph Grammars
- Validated the tool using case studies
- Showed modelling behavior with Graph Grammars is effective